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AUTHOR Underwood, Benton J.
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ABSTRACT

This research on factors influencing verbal learning and retention has used new techniques, attacked new problems, and tested new theories while trying to keep the experiments systematic. Studies conducted involved (1) the effect of varying the length of the intertrial interval on the learning and retention of different types of learning tasks; (2) differences in recall between massed repetitions and distributed repetitions; (3) evaluations of certain aspects of the "forgetting theory;" (4) "meaningfulness" as a task variable influencing the rate of verbal learning; (5) memory viewed as an ensemble of attributes--a position influenced by four lines of research dealing with rule learning to encode and decode relatively low meaningful verbal units, frequency as a discriminative cue, implicit associative responses evoked when a common word is presented the subject for learning, and position information; (6) the influence of similarity, both meaningful and formal on verbal learning; (7) the bidirectional extent of paired-associate learning; and (8) experiments which both clarified methods and exposed "artifacts" in the work of others. Listings of published reports concerning each of the studies are included. (JMC)

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FINAL REPORT

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Benton J. Underwood

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Final Report - 11 July 1969

This report summarizes the research performed under Contract Nonr-1228(15) under the title, "Factors Influencing the Learning and Retention of Verbal Materials." July 1, 1959 to June 30, 1969. This research has ranged widely; we have not hesitated to try new techniques, to attack new problems, and to test new theories. At the same time, however, we have endeavored to keep the experiments systematic so that they represent a series of probes on important problems. In summarizing the research, general conclusions will be drawn (where possible) and a listing will be made of the reports which in their detail may be used to support the general conclusion.

We continued work under this contract on the effect of varying the length of the intertrial interval on learning and retention of various types of learning tasks. This is often referred to as the influence of massed vs. distributed practice. Our general conclusion is that the influence of intervals of a few seconds to several minutes between trials has relatively little influence on rate of learning rote tasks. Only under a highly specific set of conditions will the effect attain an acceptable level of statistical significance. On the other hand, long intervals between blocks of learning trials, intervals of 24 hr., for example, have an enormous influence on retention. Such a practice schedule will, descriptively, innoculate the task against forgetting and will prevent it from interfering with other tasks. Most of these studies have been published in a series in The Journal of Experimental Psychology under the general title, "Studies of distributed practice:"

Sources of interference associated with differences in learning and retention. 1961, 61, 228-235.

Effect of interference from language habits. 1961, 62, 571-575.

Some conditions which enhance retention. 1962, 64, 355-363.

Variations in response-term interference. 1964, 68, 201-212.

Effect of distributed practice on paired-associate learning. 1967, 73, Monograph Supplement.

Differentiation and proactive inhibition. 1967, 74, 574-580.

Effect of temporal separation of two tasks on proactive inhibition. 1968, 78, 50-54.

Two integrative articles have been published dealing with the role of intertrial interval on learning and retention. These are as follows:

Ten years of massed practice on distributed practice. Psychol. Rev., 1961, 68, 229-247.

An analysis of some shortcomings in the interference theory of forgetting. Psychol. Rev., 1966, 73, 540-549.

The above work was concerned with the length of the intertrial interval (time between successive trials) on learning and retention. We believe that the conclusions we have reached on this variable are relatively durable and no subsequent work on the variable is anticipated. However, there is another way in which massing and distribution can be manipulated. In free-recall learning, for example, if an item to be learned is repeated within the list, it may be given massed repetitions or distributed repetitions. The differences in recall are very large; massed items are much more poorly learned than are distributed items. We have published one report on this phenomena and work is continuing since it appears that this particular variable is getting at a very fundamental mechanism of memory processing. The published study is:

Some correlates of item repetition in free-recall learning. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 83-94.

The study reported above (Psychol. Rev., 1966, 73, 540-549) dealt not only with the role of massed vs. distributed practice on learning and retention but also with an evaluation of certain aspects of forgetting theory. This theory was worked out in conjunction with Prof. Leo Postman (Psychol. Rev., 1960, 67, 73-95) and assumes that much of the forgetting we normally observe in everyday life as well as in the laboratory is produced by habits learned earlier (produced proactively). The theory specifies in some detail how this interference would manifest itself. We have done a series of studies as tests of the theory. It is the conclusion of these studies that the theory is not supported. No alternative theory has yet been proposed and a major explanatory problem still remains. The studies dealing with the theory were as follows:

Retention as a function of degree of learning and letter-sequence interference. Psychological Monographs, 1963, 77, No. 4.

Free learning and recall as a function of unit-sequence and letter-sequence interference. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 390-396.

Word frequency and accumulative proactive inhibition. Journal of Experimental Psychology, 1967, 74, 193-198.

Linguistic associations and retention. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 162-171.

One of the most powerful variables influencing the rate of verbal learning is the task variable known as meaningfulness. We have completed a series of studies in which this variable was manipulated in a number of tasks. These studies were performed within the theoretical framework now commonly known as the two-stage theory. This theory states that the acquisition of an association so that given A, B can be recalled, consists of two phases. First, the response term (B) must be learned as such, and second, the association must be established. This theory is still a very viable one and is widely used as a gross analytical device. The major set of studies performed under the contract was published in book form, with other studies given the usual journal publication.

Meaningfulness and verbal learning. Philadelphia: Lippincott, 1960.

Articulation in verbal learning. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 146-149.

Individual and group predictions of item difficulty for free learning. Journal of Experimental Psychology, 1966, 71, 673-679.

Response-term integration. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 432-438.

In the process of performing the studies on the role of meaningfulness, some evidence was picked up that subjects may not "use" the stimulus as presented as the associative stimulus. Rather, they seem to select certain portions, ignoring the other parts. The implications of such potential selection were first reported at the so-called second ONR Conference (Stimulus selection in verbal learning. In C. N. Cofer and B. S. Musgrave [Eds.], Verbal behavior and learning. New York: McGraw-Hill, 1963). The evidence has become increasingly clear that stimulus selection is widespread and that it deals with what is commonly called attention. The two published studies on this topic are:

Cue selection in paired-associate learning. Journal of Experimental Psychology, 1962, 64, 405-409.

Association by contiguity. Journal of Experimental Psychology, 1964, 67, 151-161.

In a paper to be published later this year (Attributes of memory, Psychological Review), memory is viewed as an ensemble of attributes. The development of this position has been heavily influenced by four lines of research which have been supported under Contract Nonr-1228(15). The first line investigated the use of rule learning to encode and decode relatively low meaningful verbal units. If a subject is presented SBU as one of a number of units to learn, he could transform (encode) this trigram into BUS at the time of learning and decode back to SBU at the time of recall. The conclusion of this work was that unless a single rule could be applied to all units in a list, learning would not be facilitated. Two reports were involved:

Coding processes in verbal learning. Journal of Verbal Learning and Verbal Behavior. 1963, 1, 250-257.

Studies of coding in verbal learning. Psychological Monographs. 1965, 79, No. 13.

A second line of research which explicates the nature of information contained in a memory deals with frequency as a discriminative cue. In a recognition situation, if two or more units have had differential frequency inputs, the frequency difference may serve as the basis for a discrimination. This approach assumes that verbal-discrimination learning, where the subject must learn to distinguish the right and wrong members of a number of pairs, is fundamentally based on a frequency difference between the right and wrong units. A number of tests have given strong support to this thinking.

Knowledge of rights and wrongs in verbal-discrimination learning. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 183-186.

A frequency theory of verbal-discrimination learning. Psychological Review, 1966, 73, 566-578.

Two tests of a theory of verbal-discrimination learning. Canadian Journal of Psychology, 1968, 22, 96-104.

Errors in recognition learning and retention. Journal of Experimental Psychology, 1968, 78, 55-63.

Verbal discrimination learning with varying numbers of right and wrong terms. American Journal of Psychology, 1969, in press.

Frequency judgments and verbal-discrimination learning. Submitted for publication.

The third line of research which aims to understand the nature of memory assumes that when a common word is presented the subject for learning, implicit associative responses may be evoked. If such implicit responses occur, expectations concerning their influence on learning will vary depending upon the type of task. For example, the implicit responses may become errors in recognition learning, but they may facilitate the learning of free-recall lists in which conceptually related words appear. Two studies are relevant:

False recognition produced by implicit verbal responses. Journal of Experimental Psychology, 1965, 70, 122-129.

Further studies on conceptual similarity in free-recall learning. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 30-35.

The fourth line of research which aims at explicating the nature of a memory deals with position information. When a word occurs in a list that is presented for only one trial, the subject may acquire some information about the position of the word relative to the other words. The evidence indicates that this position knowledge will be acquired whether the subject is told that he will be tested for his position knowledge or is not told.

Ordinal position knowledge within and across lists as a function of instructions in free-recall learning. Journal of General Psychology, 1968, 79, 301-307.

While the above four lines of research have all had positive outcomes, in the sense that the identification of the attributes involved in memory for verbal units was successful, the fact remains that in free-recall learning the subject employs retrieval or recall cues for at least some words which cannot as yet be identified. The approach has been to try to supply cues of various types to observe if recall is enhanced. In our laboratory, as well as in others, this approach has been unsuccessful:

Storage and retrieval cues in free-recall learning. Journal of Experimental Psychology, 1969, in press.

It was earlier noted that meaningfulness is a very powerful factor in verbal learning. A second factor which also exerts a strong influence is similarity, both meaningful and formal similarity. The studies which have been performed have aimed at trying to understand the subprocesses which are influenced when similarity (in its various forms) is manipulated.

Simulated similarity and mediation time in transfer. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 476-483.

An analysis of intralist similarity in verbal learning with experiments on conceptual similarity. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 447-462.

Differentiation among stimuli as a factor in transfer performance. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 172-175.

The effect of formal and associative similarity on paired-associate and free-recall learning. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 817-824.

Transfer of stimulus discrimination: Can response terms be used to differentiate stimulus terms? Journal of Verbal Learning and Verbal Behavior, 1968, 7, 825-830.

The influence of number of response terms on paired-associate learning, transfer, and proactive inhibition. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 369-377.

An association is at least to some extent bidirectional. If the subject learns to respond with B when A is presented, it has been found that there is a certain likelihood that he will also respond with A when B is presented. Work on these so-called backward associations have been concerned with determining whether their properties are the same as the forward associations. Our studies lead to an affirmative conclusion.

Retroactive inhibition of R-S associations. Journal of Experimental Psychology, 1962, 64, 400-404.

Bidirectional paired-associate learning. American Journal of Psychology, 1963, 76, 470-474.

Any experimental discipline must develop new methods and must continually refine and question those in use. Over the period of this contract we have found it essential not only to conduct experiments to clarify methods but also to conduct experiments to expose artifacts in the work of others. A number of reports deal with such matters.

An evaluation of two problems of method in the study of retention. American Journal of Psychology, 1962, 75, 1-17.

One trial learning? Journal of Verbal Learning and Verbal Behavior, 1962, 1, 1-13.

Item selection in paired-associate learning. American Journal of Psychology, 1962, 75, 353-371.

Proactive inhibition in short-term retention of single items. Journal of Verbal Learning and Verbal Behavior, 1962, 1, 153-161.

Paced versus unpaced recall in free learning. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 288-290.

Degree of learning and the measurement of forgetting. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 112-129.

Verbal learning as related to point of time in the school term. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 222-225.

Benton J. Underwood, Project Director